# PDF uncertainties for W mass measurements at the Tevatron

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# Overview

- Procedure
- $m_W$ uncertainties
- Constraints from measuring $\sigma(1<|\eta_l|<2)/\sigma(|\eta_l|<1)$
- Conclusions

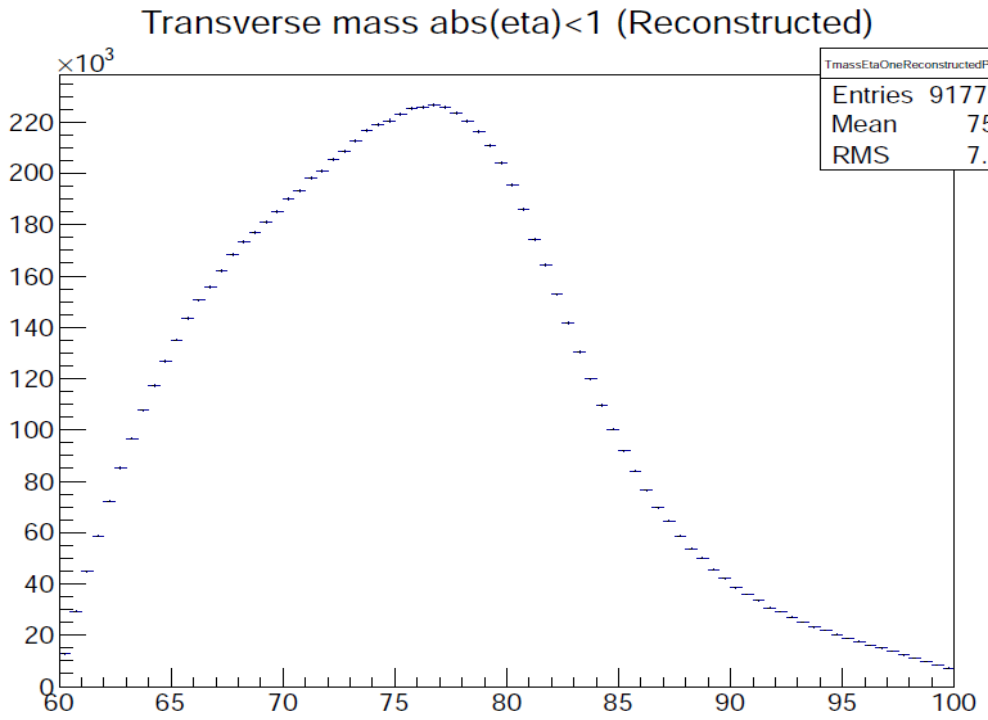
# Procedure

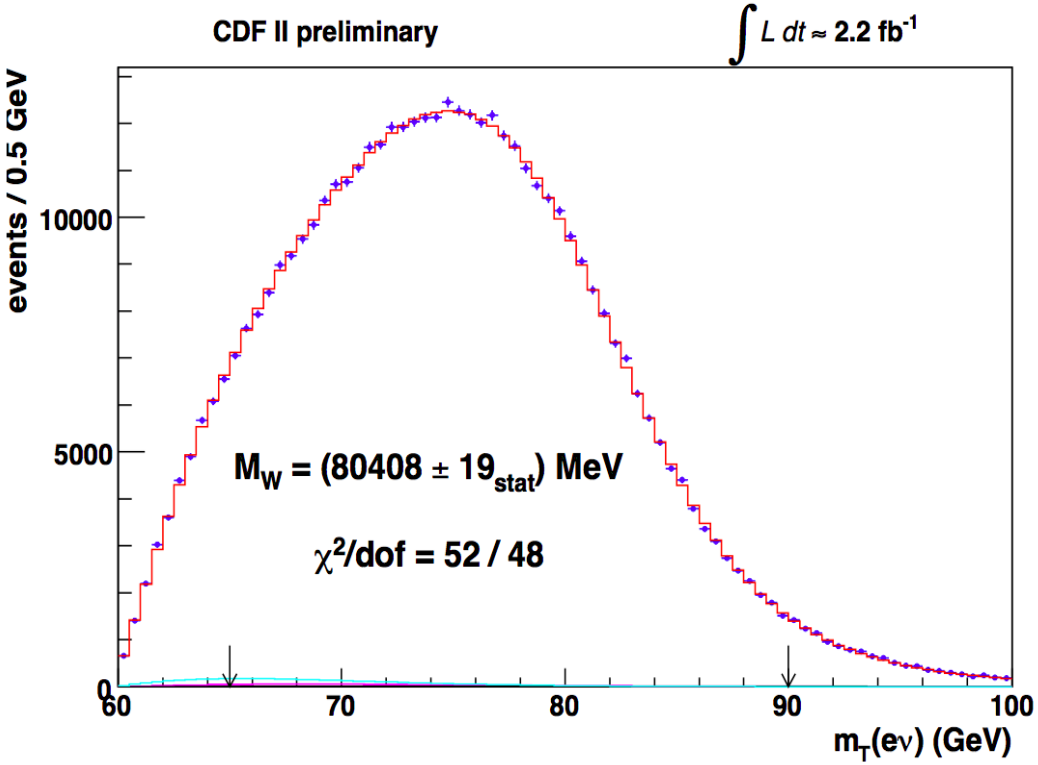
- Run 35 million Powheg NLO+NLL QCD events
  - Use reweighting scheme for multiple PDFs
    - MSTW2008 68% & 90%, CT10, NNPDFs ($\alpha_s$ = 0.118 & 0.120)

- Apply lepton and recoil smearing based on CDF resolutions
  - Electron
    - $\sigma(E_T)/E_T = \sqrt{(0.126^2/E_T + 0.013^2)}$
  - Recoil
    - $\sigma(u) = 0.8\ \sqrt{u}$
    - $u_{meas} = 0.65\ u_{true}$
    - recoil angle: flat distribution with width of 0.25 radians
    - underlying event: gaussian with 3.5 GeV sigma

# $m_W$ fit distributions

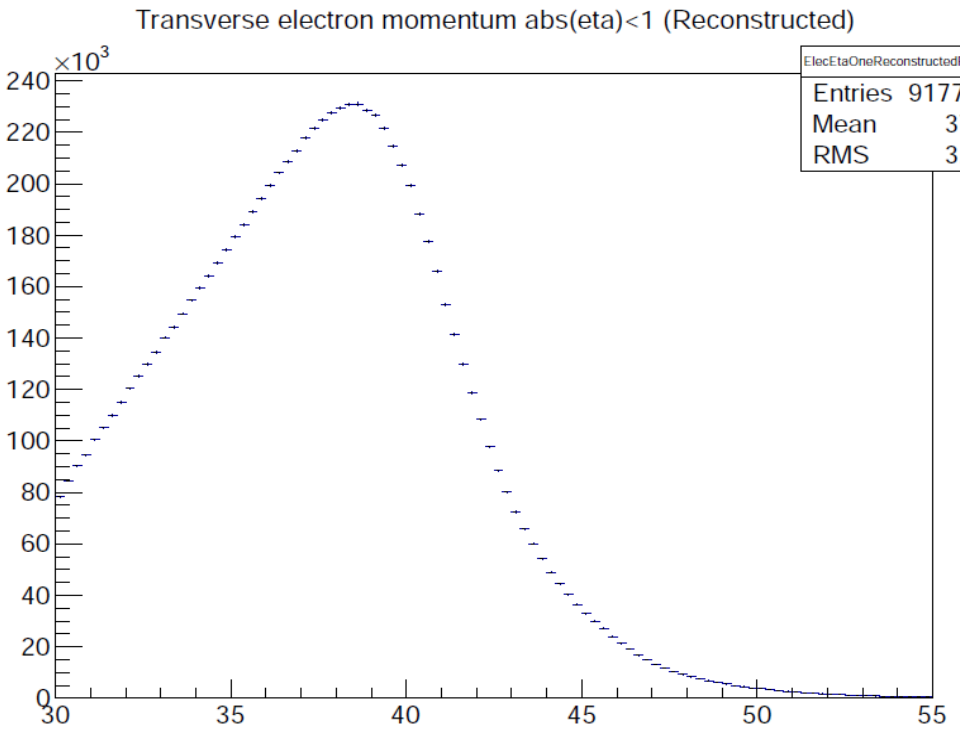
- Apply selection cuts
  - e,ν $p_T$ 30-55 GeV, $m_T$ 60-100 GeV, u<15, $|\eta_e| < 1$

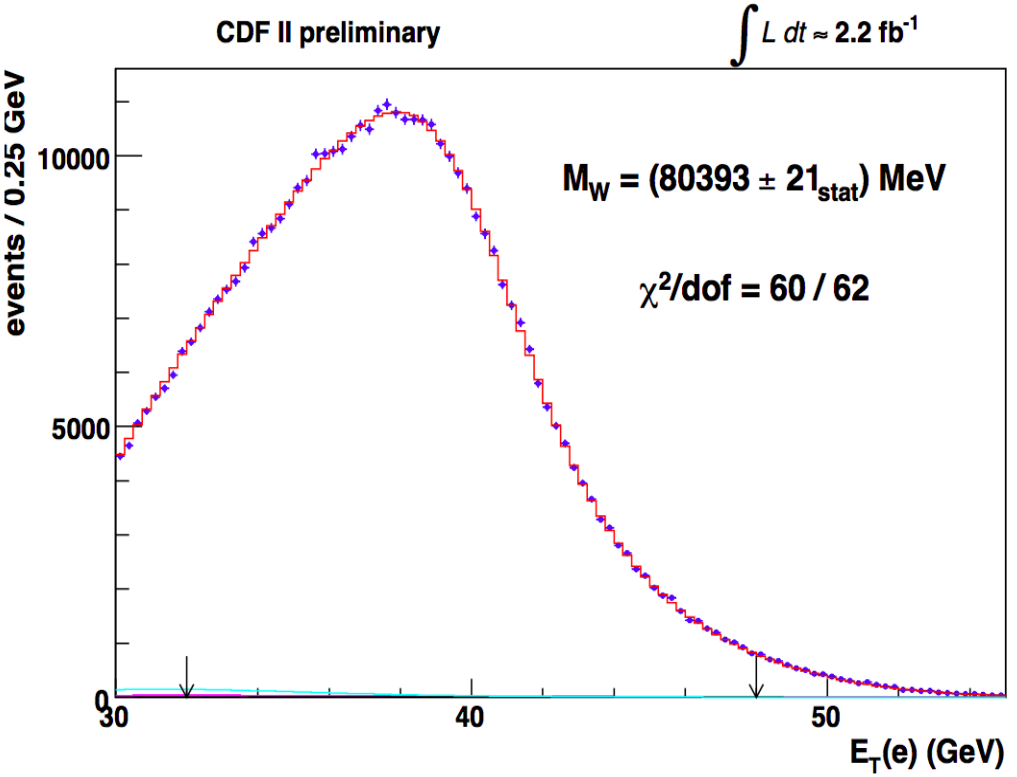


# $m_W$ fit distributions

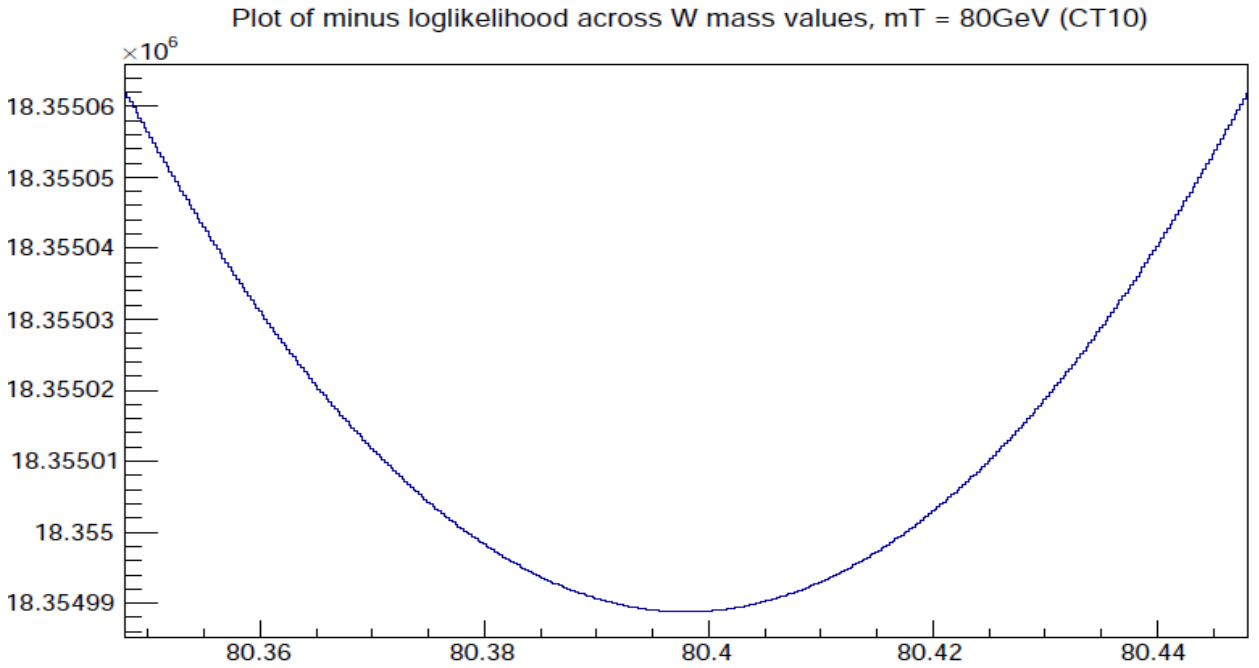
- Data distributions broadly reproduced



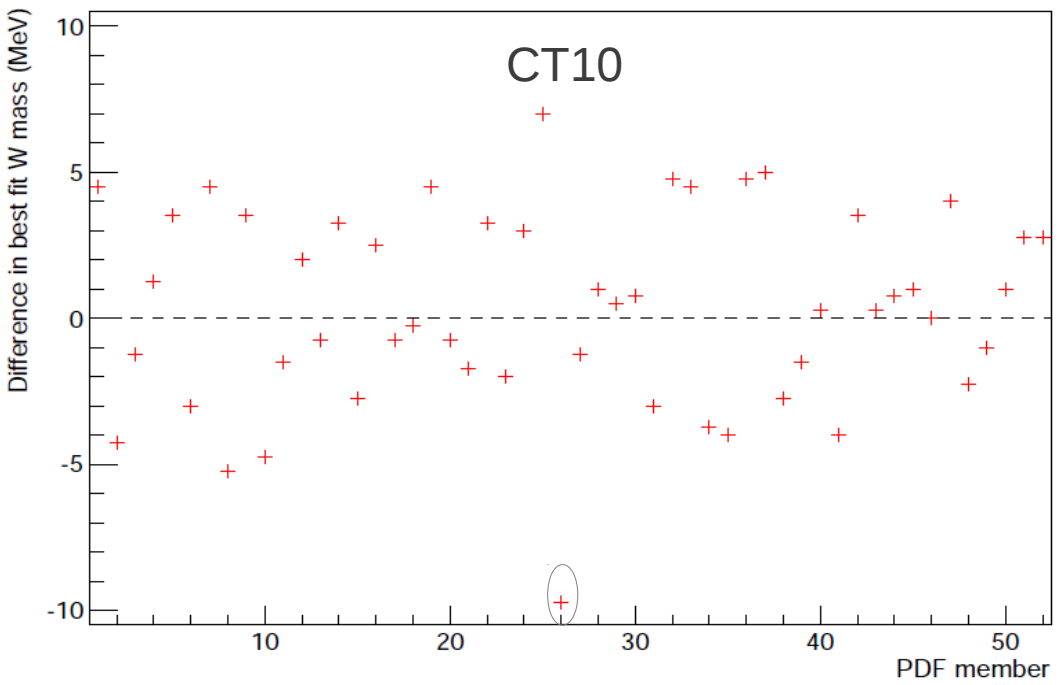
# Likelihood fit

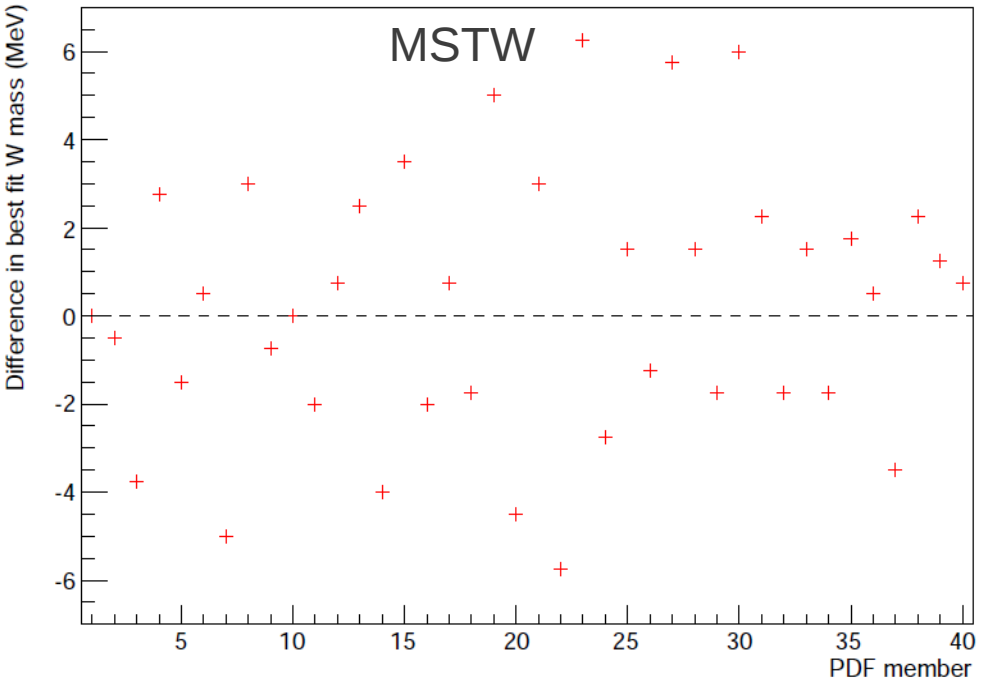
- Fit for $m_W$ by producing templates using CT10 PDF and reweighting Breit-Wigner distribution
  - 4 MeV statistical uncertainty in a given fit
  - >95% correlation between fits



# $m_W$ uncertainties

- CT10 uncertainty dominated by one eigenvector
- MSTW uncertainties relatively small




Central values of different PDF sets agree to better than 1 MeV

# $m_W$ uncertainties

Symmetric eigenvector uncertainty: ½ the difference between + and – eigenvectors
If both eigenvectors shift the mass in the same direction take ½ the larger deviation

| PDF set | $m_T$ fit | e $E_T$ fit | $\nu$ $p_T$ fit |
|---|---|---|---|
| CT10 | 16.5 | 15.8 | 18.2 |
| MSTW90 | 12.4 | 12.0 | 14.0 |
| MSTW68 | 6.6 | 6.4 | 7.1 |
| NN 0.118 | 6.2 | 6.1 | 7.1 |
| NN 0.120 | 5.8 | 5.8 | 6.5 |

Uncertainty changes by 0.8 MeV if use average of 35 evaluations with samples of 1 million events each

CT10 x (MSTW68 / MSTW90): 8.8 MeV

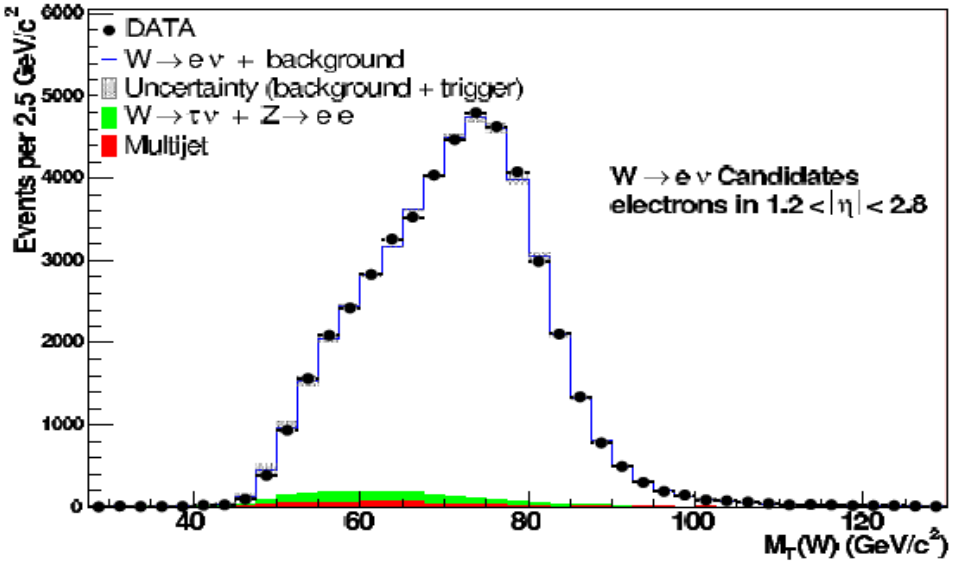
CT10 x (1 / 1.6): 10.3 MeV

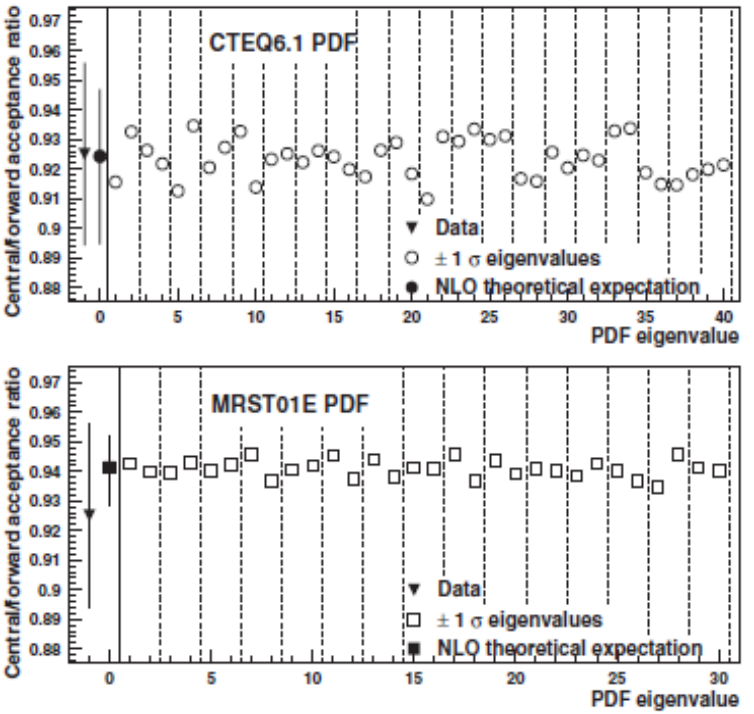
c.f. CDF uncertainty: 11 MeV (MSTW2008 68%)

c.f. PRD 83, 113008: 3 MeV (MSTW2008)

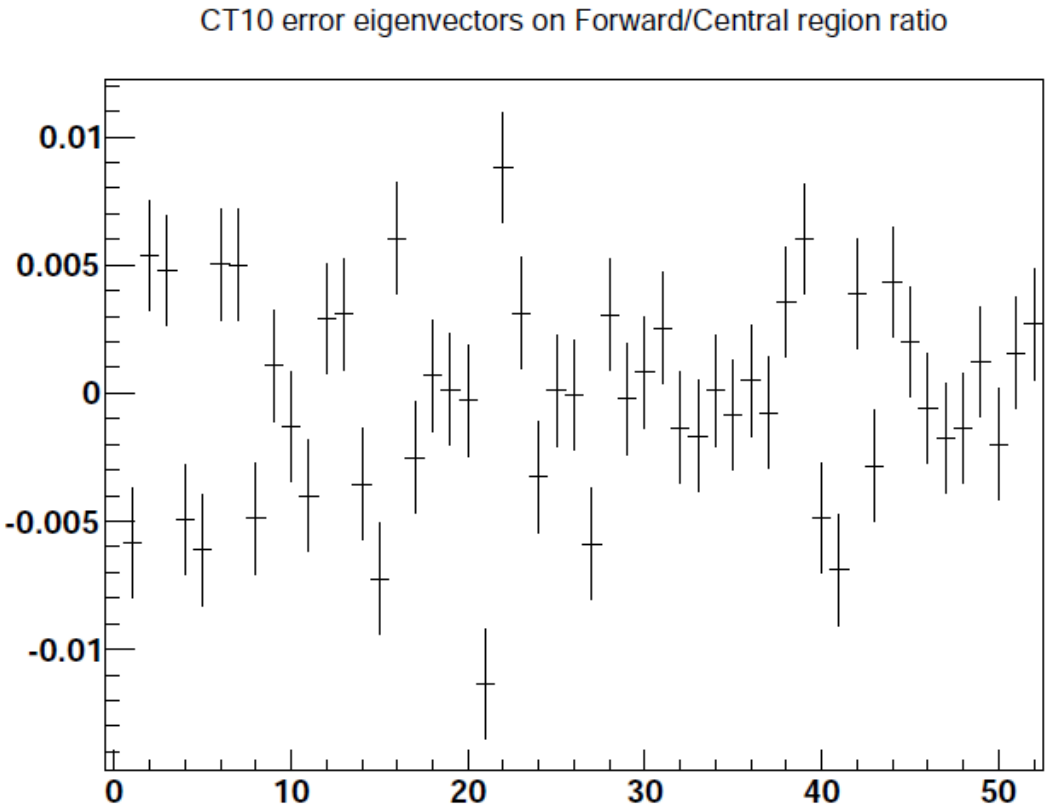
# Forward / central cross section

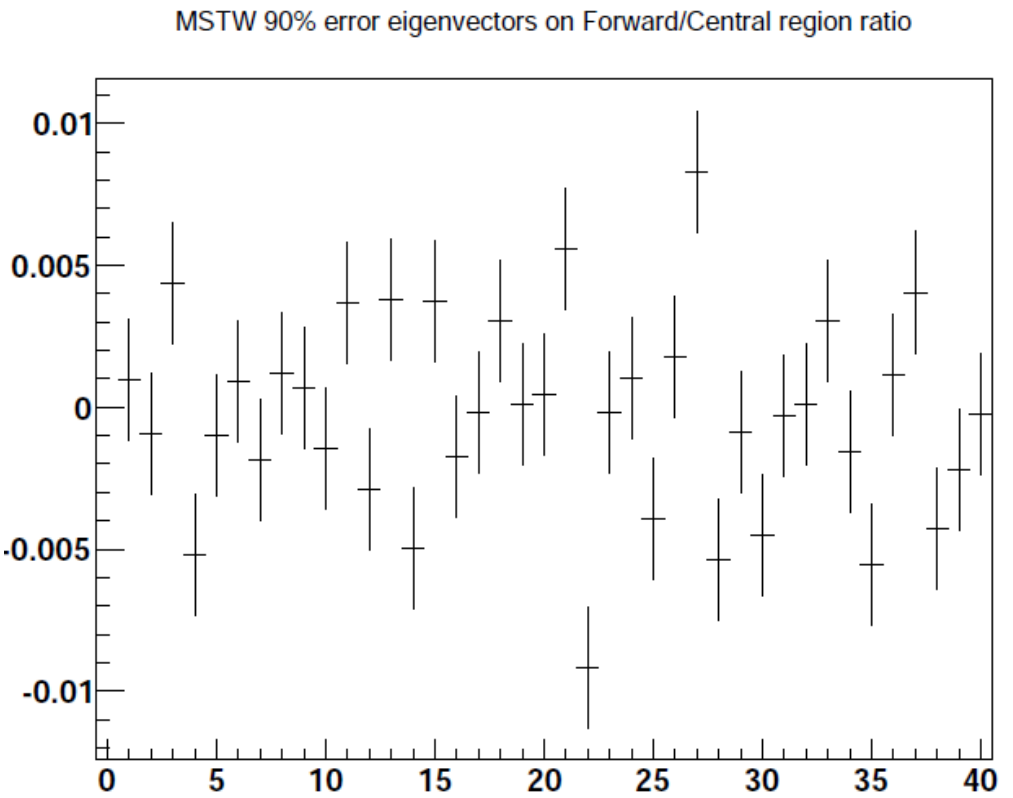
- PDF uncertainty on $m_W$ due to $\eta_l$ restriction
- Potentially reduce by measuring relative cross section for forward to central leptons
  - Such a measurement was performed by CDF with up to 220 $pb^{-1}$ of data



# Forward / central cross section




$\sigma(1<|\eta_l|<2) / \sigma(|\eta_l|<1)$

| PDF set | Fractional uncertainty |
|---|---|
| CT10 | 4.0% |
| MSTW90 | 2.9% |
| MSTW68 | 1.6% |

# Conclusions

- Found PDF uncertainties larger than other studies but smaller than experiments
  - Underestimate due to reweighting?
  - Inflation due to limited statistics?

- Some interesting features:
  - MSTW 68% / MSTW 90% is $1.9^{-1}$
  - CT10 uncertainty dominated by one eigenvector
  - NNPDF gives smallest uncertainty

- Possible reduction in uncertainties from measurement of forward / central cross section ratio
  - 1% precision = 4 MeV on $m_W$